between the two regions, but the correspondences are certainly extraordinary.

We shall hope soon to hear that the excellent and practical work of the New Jersey Survey has been appreciated by the school-boards of that State, and that copies of this new topographic map and of the appropriate local sheet of the State atlas have been placed in all the high schools and academies. Teachers could then carry on the modern reform in geographic teaching beyond its simple first step, which involves a map of the school-yard and home town, to the more difficult second step, in which correct maps of larger areas are needed. Until this is generally possible and actual, reform in geographic teaching will not go far beyond the merest elements of the subject. If Professor Cook is as successful in putting the State maps into practical use as he has been in surpervising their preparation, we shall owe him a double debt.

W. M. D.

TISSOT'S THEORY OF THE PROJECTION OF MAPS.

THE question as to what projection to select for a certain map is one of great importance to the cartographer. As is well known, the earth's surface cannot be represented on a plane sheet of paper without distorting the lengths of lines, and without altering the size of surface or of angles; and for this reason it becomes the duty of the cartographer to select a projection, or a method of representing the curved surface on a plane, by which the distortions and alterations become as small as possible. Merit is due a French geographer and mathematician, M. A. Tissot, for having first pointed out a method by which this problem can be easily solved. Unfortunately his book, which was published in 1881,[1] is little known, and therefore the necessary process of replacing the old projections, which he has proved to be inadequate, by new and better ones, is making hardly any progress.

The principle which underlies his researches is so clear and simple, that it may be stated here. Tissot assumes an infinitely small circle on a curved surface. If this surface is represented on a plane, the circle assumes the shape of an ellipse, on account of the unavoidable distortion. The great and small diameters of this ellipse are a and b, and their ratio is a measure of the angular distortion, while their product is a measure of the alteration of surface. The ratio between a and the radius of the original small circle, r, is a measure of the alteration of scale. Tissot shows how to compute the length of the axes of this ellipse, which he calls the indicatrix, as indicating the distortion, and how to determine their direction.

This general theory is next applied to the construction of maps. For any law according to which a system of meridians and parallels is constructed, we can compute a and b as functions of latitude and longitude, and thus a means is obtained of studying the distortions all over the surface of the map.

Maps are made to serve various purposes. In many cases it is necessary that a square inch on one part of the map should represent the same area as a square inch on any other part of the map, or, as it is generally expressed, that the areas should be preserved. Projections of this kind are called 'equivalent,' while Tissot introduces the expression 'authallic.' It is evident that every projection in which the indicatrix-ellipse is equal to the small circle, is equivalent. In other cases it is desirable that each small part of a map be similar to the corresponding part of the earth. This is possible only when the indicatrix is a circle; that is, when $a = b$. These projections are called by Tissot 'autogonal,' as the angles are preserved. In still other cases we do not mind an alteration of angle and surface, but wish to preserve the length of lines as much as possible. For this purpose the ratio of a, b, and r must be as near 1 as possible. Tissot calls projections in which angles and surfaces are altered 'aphylactic.'

The problem, according to this, is very simple. According to the purpose for which a map is intended, we choose one of the three classes of projections. It is the task of the cartographer to select the projection for a map so that, if one property is preserved, the others are changed as little as possible. If, for instance, the areas are preserved, the angles must be altered as little as possible. A projection which has this property is called by Tissot 'perigonal,' while an autogonal projection in which the alteration of surface is a minimum is called 'perihallic.' We have seen that the distortion is a function of latitude and longitude. If, then, a country of limited extent is given, we must study this function over the whole area of the map; and, as there are an infinite number of each class of projections, we are able to select the function so that the unavoidable distortion of one of the elements becomes a minimum.

The last case, that of 'aphylactic' projections, has been treated by Airy in his projection by balance of errors; but the theory of these projections and their application to certain areas has first been given by Tissot. His admirable work must form the basis of all future cartographic work.

The importance of his researches may be understood by his discussion of the distortions of the map of France. The great map of the war department of that country is constructed in Bonne's projection; the map being equivalent, and the maximum alteration of angle being 18 minutes, and the greatest distortion of scale $\frac{1}{880}$. These would have been 10′ 30″ and $\frac{1}{660}$ respectively, if a more suitable central meridian had been selected; but they would have been reduced to 25 seconds and $\frac{1}{110}$, if Tissot's principles had been applied.

It is to be hoped that the thorough study of his work will lead to the adoption of better projections than those which are at present in use.

[1] *Mémoire sur la Représentation des Surfaces et les Projections des Cartes Géographiques.* Par M. A. TISSOT. Paris, Gauthier-Villars.

SCHOOL-WORK AND EYESIGHT.

Five Per Cent of Near-sighted Children in an Old, Badly Illuminated and Ventilated School-Building, and only 2.8 in a New, Well-arranged Building. — School Life, according to Dr. Tiffany of Kansas City, has Little or Nothing to do in the Development of Ocular Anomalies.

IN the chapter entitled 'Our School Systems,' which is one of the most interesting and suggestive of all those that will accompany the forthcoming annual report of the United States commissioner of education, the effect of school-work on eyesight will be very fully discussed, chiefly in extracts from the reports of city school superintendents.

Mr. George Howland, superintendent of Chicago schools, says: —

"In the old school-rooms, and we need not go far back for them, the light was often so insufficient, that much harm undoubtedly resulted to the eyes of the children. But in our newer buildings so much thoughtful attention has been given to this subject, that the evil no longer exists there. Pupils, too, have been allowed to study with too little regard to position, and with the object too near the eye; perhaps with the result of myopia in some cases, but by no means, in my judgment, to the extent often charged.

"The oculist is too definite, and too certain in his knowledge. Why should the book or paper always be 'fifteen inches from the eye'? Five feet seven may be the average height of a man, and eight the right number for his boot; but is he to be considered deformed, or a monstrosity, who is five feet six, or who wears a number seven or nine?

"Of over eighty thousand children in our schools, I have never seen one voluntarily take that distance, and have eminent professional opinion that such an enforced rule would work more harm than ever our neglect has done. Nothing will lie so unblushingly as figures."

The following, from the report of the board of education, describes the results of a recent examination of the eyes of the pupils of two of the leading public schools of Memphis, Tenn: —

"The eyes of 681 pupils have been examined. Of these, 588 had perfect sight, 60 had imperfect sight from general causes, and 30 had impaired vision from eye-strain. It is interesting to trace the gradual increase of this form of impaired sight (near-sightedness) from the primary classes, where it is hardly noticeable, to the highest grade, where it reaches fifteen per cent. In this particular my results are similar to those obtained by examiners in this and other countries. But a point which should not be overlooked is this, — that my examinations were confined to pupils in two different school-buildings, each of which may be taken as a sample of its class. The Market Street building has been recently constructed,